time-constant-to-discharge is 0.8 to 1.6 µs. To charge the antenna **236** to a certain charge, Q, for a capacitance based on a dielectric constant for "free space" of ε_0, i.e., $C\varepsilon_0$, a voltage of $V = Q/C\varepsilon_0$. is required. For the case of a capacitance, i.e., $C\varepsilon_{0+\varepsilon}$, which includes a detectable hand in "free space," the voltage required to store charge Q is $Q/C\varepsilon_{0+\varepsilon}$. However, $C\varepsilon_{0+\varepsilon}$ is about twice $C\varepsilon_0$, so that the voltage peak for the detected hand is about half of the no-hand-present case.

[0100] The diode XD1 **258** allows positive forward conduction but cuts off the negative backward conduction of a varying signal pulse. The forward current, or positive peak of the current, tends to charge the capacitor XC5 **260**. The diode XD1 **258**, the resistor XR8 **262**, the capacitor XC5 **260** and the bleed resistor XR10 **264** comprise a peak detector network. XD1 **258** and XC5 **260** capture the positive peak of the exponential waveform. XR8 **262** prevents oscillation of XU1A **242**. XR8 **262** limits the charging time constant to 5 ms, where XR8 **262** is 4.99 kΩ and XC5 **260** is 0.1 µF. This has an averaging effect on the peak detection and prevents noise spikes from pumping up the detector. The resistor XR10 **264** discharges the detector at a half-second time constant.

[0103] When the hand is detected, the stored charge on XC8 **260** is such that the voltage is sufficient to raise the input to the non-inverting terminal **266** of operational amplifier XU1B **268** above ½XV_DD, so as to drive that operational amplifier output to a usable linear voltage range.

[0100] The combination of the resistor XR1 **270** (e.g., 499 kΩ) and the capacitor XC1 **272** (e.g., 0.1 µF) comprise a low pass filter with a corner frequency of 1/XR1•XC1 (e.g., 20Hz), which corresponds to a time constant of XR1•XC1 (e.g., 50 ms). This filter is for rejection of large 50Hz or 60Hz noise. These "high" frequencies are effectively shorted to ground. It is particularly helpful when the towel dispenser proximity detector is powered from an AC-coupled supply. The ubiquitousness of the AC power frequency, however, makes this protection desirable, regardless.

[0105] The signal is next amplified by an operational amplifier XU1B **268**, which has a gain of 22. The resistor XR5 **277** serves as a feedback resistor to the negative (inverting) input terminal **279** of the operational amplifier **268**. There is a ½ XV_DD offset provided by the voltage divider network of XR3 **274** and XR11 **276**. The output rests against the negative rail until a peak exceeds ½ XV_DD. The charge

time adjustment XVR1 becomes a very simple and sensitive way to adjust to this threshold. A setting of 3 V between test points XTP1 **278** and XTP2 **280** is recommended. This adjustment is made with all external capacitive loads (i.e., plastic and metal components) in place.

[0106] The output comparator **282** (Figure 10D) is connected to the signal processing from the operational amplifier 268 (Figure 10C) by the auto-compensate capacitor XC3 **284** (Figure 10D). This makes the circuit insensitive to DC levels of signal, but sensitive to transients, e.g., a waving hand. As long as the charge-time adjustment function remains in a linear range, the sensitivity to a moving hand will be stable.

[0107] The capacitor XC4 **286** allows the reference level (REF) **288** to track with approximately 50Hz or 60Hz noise on the SIGNAL **290** and not cause erroneous output pulses, since the AC noise will also track on the REF **288** (non-inverting) input to the comparator **282**.

[0108] The output stage of the proximity detector is implemented as a variable threshold comparator, XU2B **282**. The signal is set up with an offset voltage, where the resistors XR7 **292** and XR12 **294** are equal and divide the V_{DD} voltage into two ½ V_{DD} segments. Three sensitivity settings are provided by SW1 **296**, high, medium, and low. These settings include where the reference voltage is the voltage drop across XR6 **298** (499 kΩ) with the remainder of the voltage divider equal to XR19 **300** (453 kΩ) plus XR16 **302** (20 kΩ) plus XR14 **304** (10 kΩ). This is the high setting, since the base reference voltage ($V_{DD}\bullet499/[499 + 483]$} is greater than, but almost equal to the base signal value ($V_{DD}\bullet499/[499+499]$}. The signal must overcome, i. e., become smaller than the reference voltage (since the input is an inverting input) than the reference voltage, in order to swing the output **306** of the comparator XU2B **282** high and activate, say, a motor-control latch (not shown in Figure 10D). The medium sensitivity setting, in Figure 10E, of switch XSW1 **296** (bypassing XR14, **304** 10 Ωk, by way of switch XSW1 **296**) widens the difference between the signal and reference levels. The low sensitivity setting (bypassing XR14 **304**, 10 Ωk, and XR16 **302**, 20 Ωk, by way of switch XSW1 **296**), widens that difference between the signal and reference levels even more. Consequently, a larger difference between the signal and the reference voltage must be overcome to activate

the motor by way of the comparator XU2B **282** and the motor-control latch (not shown in Figure 10D).

[0109] The entire sensor circuit runs continuously on approximately 300 μA at a supply voltage (XV$_{DD}$ **234**) of 5 V.

[0110] Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.